Galer, Rose

From: Rose, Jay
Sent: Tuesday, December 18, 2007 9:58 AM
To: Galer, Rose
Subject: FW: Need Some Inputs-- Finck 2007d
Attachments: SWCR&MSR.doc

Frank,
Attached is a short description and highlights of SCWRs and MSRs. These are extracted from the Gen IV 10-Year Program Plan.

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Phillip J Finck/FINCPJ/CC01/INEEL/US

10/22/2007 05:00 PM

To "Schwartz, Francis (NE-HQ)" <Francis.Schwartz@hq.doe.gov>

cc "Swichkow, Deborah" <DEBORAH.SWICHKOW@Nuclear.Energy.gov>, "Wheeler, Jack" <JACK.WHEELER@Nuclear.Energy.gov>, "Rose, Jay" <Jay.Rose@tetratech.com>, "Perry, Jeffrey" <Jeffrey.Perry@Nuclear.Energy.gov>, "Jones, Leon H (NE-ID)" <joneslh@id.doe.gov>, "Roald Wigeland" <Roald.Wigeland@inl.gov>, "Ronaldo Szilard" <ronaldo.szilard@inl.gov>

Subject Re: Need Some InputsLink

Frank: Ronaldo will deliver the first two by tomorrow COB

As to the third (LWR-HGTR) can someone clarify what the process is? the similarity to DUPIC, from what I know, is very slim

For the R&D part (last section of your email) we probably can put something together, but I need to find manpower, and it is a little late out East. I will take the opportunity of another telecon in the AM

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10/22/2007 04:19 PM

To "Roald Wigeland" <Roald.Wigeland@inl.gov>, phillip.finck@inl.gov

cc "Rose, Jay" <Jay.Rose@tetratech.com>, "Perry, Jeffrey" <Jeffrey.Perry@Nuclear.Energy.gov>, "Jones, Leon H (NE-ID)" <joneslh@id.doe.gov>, "Swichkow, Deborah" <DEBORAH.SWICHKOW@Nuclear.Energy.gov>, "Wheeler, Jack" <JACK.WHEELER@Nuclear.Energy.gov>

Subject Need Some Inputs

Roald and Phillip -

We need a short paragraph on each of the following "alternatives" considered but dismissed. I hope at least for the first two you can just draw on information from the Gen IV program. I expect much of the same argument for the first two may apply to the third item.

- Supercritical Water Reactor
- Molten Salt Reactor
- LWR-HTGR Recycle (similar to DUPIC type process for HWR)

We also need help defining general categories of R&D and potential timeframes for completion of that R&D that we believe might be required for each of the four existing action alternatives (GNEP Closed Cycle, Thorium Open Cycle, Closed Thermal, and Open HWR/HTGR).

Jay can help define better if you have questions.

If it is possilbe to turn this around tomorrow, it will be much appreciated.

Thanks

Frank

Supercritical-Water-Cooled Reactor

SCWRs are promising advanced nuclear systems because of their high thermal efficiency (i.e., about 45% versus about 33% efficiency for current LWRs) and considerable plant simplification. SCWRs are basically LWRs operating at higher pressure and temperatures with a direct, once-through cycle. Operation above the critical pressure eliminates coolant boiling, so the coolant remains single-phase throughout the system. Thus, the need for recirculation and jet pumps, pressurizers, steam generators, and steam separators and dryers in current LWRs is eliminated.

The main mission of the SCWR is generation of low-cost electricity (note that the SCWR begins with a thermal neutron spectrum and once-through fuel cycle, but may ultimately be able to achieve a fast-spectrum with recycle). It is built upon two proven technologies: LWRs, which are the most commonly deployed power-generating reactors in the world, and supercritical fossil-fired boilers, a large number of which are also in use around the world.

For any SCWR design, materials for reactor internals and fuel cladding will need to be evaluated and identified. Zirconium-based alloys, so pervasive in conventional water-cooled reactors, will not be a viable material for most of the proposed SCWR core designs without a thermal and/or corrosion-resistant barrier.

Based on the available data for other alloy classes, no alloy has currently received enough study to unequivocally ensure its viability in a SCWR. A variety of potential materials have been identified that should be given consideration for both fuel cladding and core internal components.

Molten Salt Reactor

Molten Salt Reactors (MSRs) are liquid-fueled reactors that can be used for production of electricity, actinide burning, production of hydrogen, and production of fissile fuels. Electricity production and waste burndown are envisioned as the primary missions for the MSR. Fissile, fertile, and fission isotopes are dissolved in a high-temperature molten fluoride salt with a very high boiling point (1,400°C) that is both the reactor fuel and the coolant. The near-atmospheric-pressure molten fuel salt flows through the reactor core. The traditional MSR designs have a graphite core that results in a thermal to epithermal neutron spectrum. Alternative designs are now being explored with no reactor internals and a fast neutron spectrum. In the core, fission occurs within the flowing fuel salt that is heated to ~700°C, which then flows into a primary heat exchanger where the heat is transferred to a secondary molten salt coolant. The fuel salt then flows back to the reactor core. The clean salt in the secondary heat transport system transfers the heat from the primary heat exchanger to a high-temperature Brayton cycle that converts the heat to electricity. The Brayton cycle (with or without a steam bottoming cycle) may use either nitrogen or helium as a working gas.

Development of an MSR involves multiple fuel cycle challenges. Specifically, because the system is a molten fluoride salt system, there are unique chemical issues not associated with other reactors. There is a need to develop a fluoride high-level waste form and an integrated fuel recycle strategy.

The current regulatory structure was developed with the concept of solid-fuel reactors, but liquid fueled reactors use different approaches to reactor safety than solid-fueled reactors. The comparable regulatory requirements for this system must be defined. Using current tools, appropriate safety analysis is required followed by appropriate research on the key safety issues.

The major challenges in materials R&D is to identify and qualify materials with properties appropriate for MSR operating conditions, including corrosion resistance, mechanical performance, and radiation performance. The primary materials of interest are the moderator (graphite) and the reactor vessel/primary loop alloy (presently a Ni-based alloy). It is also necessary to develop corrosion control and coolant monitoring strategies for protecting the reactor vessel and primary piping alloys.